



2010 Minerals Yearbook

COBALT

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In 2010, world production of refined cobalt increased by 28% to a record quantity of more than 76,000 metric tons (t). The increase was the result of significant increases in production from many countries, including China, the world's leading cobalt refiner. The United States did not refine cobalt in 2010. A negligible amount of byproduct cobalt was produced as an intermediate product from the mining and refining of platinum-group metal (PGM) ore. No cobalt was sold from the National Defense Stockpile (NDS) in 2010. Prior to 2010, the NDS had sold cobalt every year since cobalt sales began in 1993.

According to the Cobalt Development Institute (2011), world apparent consumption of cobalt was approximately 61,000 t, about 9% more than that of 2009. Apparent consumption increased in China, Europe, other Asia, and the United States. While Chinese consumption did increase from that of 2009, some of that country's apparent consumption was the result of a stockpile of 21,000 t of contained cobalt that had been accumulating since 2008 (Xu, 2011, p. 7). Cobalt prices trended downward in 2010. Salient U.S. and world cobalt statistics for 2006–10 are listed in table 1.

Cobalt is a metal used in numerous diverse commercial, industrial, and military applications, many of which are considered strategic and critical. On a global basis, the leading use of cobalt is in rechargeable battery electrodes. Superalloys, which are used to make parts for gas turbine engines, are another major use for cobalt. Cobalt is also used to make airbags for automobiles; catalysts for the petroleum and chemical industries; cemented carbides (also called hardmetals) and diamond tools; corrosion- and wear-resistant alloys; drying agents for inks, paints, and varnishes; dyes and pigments; ground coats for porcelain enamels; high-speed steels; magnetic recording media; magnets; and steel-belted radial tires.

Legislation and Government Programs

The Defense Logistics Agency (DLA), U.S. Department of Defense, changed the name of the Defense National Stockpile Center to DLA Strategic Materials. Early in fiscal year 2010 (October 1, 2009, through September 30, 2010), DLA sold 6 t of cobalt metal valued at \$284,000 under a basic ordering agreement (BOA); no cobalt was sold during calendar year 2010 (table 2). The fiscal year sales represented only 1% of the 454-metric-ton (1-million-pound) maximum allowed for sale under the 2010 Annual Materials Plan (AMP). The AMP for fiscal year 2011 (October 1, 2010, through September 30, 2011) was reduced to 301 t (663,709 pounds), which was equal to the total uncommitted cobalt inventory held by DLA on December 31, 2010. Sales of cobalt were curtailed in order to hold a goal quantity equivalent to 1 year's AMP (U.S. Department of Defense, 2011, p. 2, 6–7, 9).

The U.S. Department of Energy released a strategy on critical materials used in clean energy technologies. Although

included in the strategy because of its use in batteries for electric vehicles, cobalt was identified as “not critical” in terms of risk of supply disruption in the short (0–5 years) or medium (5–15 years) term, owing to a forecast of significant increases in global production (U.S. Department of Energy, 2010).

Production

With the exception of negligible amounts of byproduct cobalt produced from Stillwater Mining Co.'s PGM operation in southeastern Montana, the United States did not mine or refine cobalt in 2010. Cobalt-bearing nickel sulfate produced from Stillwater's mining and refining operations was sold to several companies. In late 2010, OJSC MMC Norilsk Nickel (Stillwater Mining's majority shareholder) sold all of its equity interest in the company to an unspecified number of investors (Stillwater Mining Co., 2011, p. 9, 26).

Formation Metals Inc. completed stage 1 construction of its Idaho cobalt mine, which consisted primarily of clearing timber from the site in preparation for laying foundations for mine site structures. The company continued to actively pursue financing for further construction, and received certificates of allocation from the State of Idaho for \$77.7 million in Federal Stimulus Program Recovery Zone Facility Bonds. Formation's Idaho Cobalt Project entailed an underground cobalt-copper-gold mine and mill complex in the Idaho Cobalt Belt in Lemhi County and retrofitted Big Creek hydrometallurgical complex near Kellogg, ID, to refine the concentrates. The refinery was to produce approximately 1,500 metric tons per year (t/yr) of cobalt as high-grade cathode suitable for critical superalloy applications. Formation estimated that construction would take 12 to 14 months to complete (Formation Metals Inc., 2011, p. 5–9).

Kennecott Minerals Co., a fully owned subsidiary of Rio Tinto (Melbourne, Australia, and London, United Kingdom), began construction at its Eagle project in Michigan. The small underground nickel-copper mine in the Eagle deposit in the Yellow Dog Plains area northwest of Marquette and rehabilitated mill in Humboldt Township would produce concentrate for export. At the proposed rate of 17,300 t/yr of nickel, an estimated 400 t/yr of cobalt would be produced during a 6-year mine life, based on nickel and cobalt grades in the resource. Kennecott planned to begin production in late 2013 (Kennecott Eagle Minerals Co., 2010).

The Minnesota Department of Natural Resources, U.S. Army Corps of Engineers, and U.S. Forest Service were preparing a supplemental draft environmental impact statement for PolyMet Mining Corp.'s NorthMet project. The project entailed open pit mining of the NorthMet polymetallic deposit in the Duluth Complex of northeastern Minnesota, refurbishing the crushing and grinding equipment in the company's nearby Erie plant, and adding a new beneficiation circuit and hydrometallurgical

plant. PolyMet planned to develop the project in stages and sell separate copper and nickel concentrates during the construction and commissioning of the hydrometallurgical plant, which would produce copper cathode, a nickel-cobalt mixed hydroxide, and a precipitate of PGMs and gold. PolyMet and Swiss trading firm Glencore International AG had a strategic partnership whereby Glencore would invest in Polymet and purchase or market NorthMet's concentrates, intermediate products, and metal (PolyMet Mining Corp., 2011, p. 11–12, 24–25).

U.S. processors made cobalt chemicals and cobalt metal powders from refined cobalt materials and (or) cobalt-bearing scrap. U.S. Geological Survey (USGS) data on chemical and metal powder production, shipments, and stocks were derived from a monthly voluntary survey of U.S. cobalt processors. Information from this survey was used to prepare the statistics on cobalt consumption and stocks in table 3. The sole producer of cobalt metal powder, Global Tungsten & Powders Corp. of Towanda, PA, produced the cobalt as a byproduct of tungsten recovered from cemented carbide scrap. U.S. production and shipments of cobalt metal powder are withheld to avoid disclosing company proprietary data.

Consumption

U.S. apparent consumption for 2010, as calculated from net imports, consumption from purchased scrap, and changes in Government and industry stocks, was 36% higher than that of 2009 (table 1). The increase was primarily because net imports in 2010 were significantly higher than those of 2009.

U.S. reported consumption of cobalt in 2010 was 8% higher than that of 2009. Metallurgical industries used 9% more cobalt than in 2009; cobalt consumption for chemical uses was 3% higher. Reported consumption was derived by the USGS from voluntary surveys of U.S. operations. Most of the data on cobalt chemical uses were obtained from the cobalt processors survey. A second survey covered a broad range of metal-consuming companies, such as cemented carbide, magnetic alloy, and superalloy producers. For this survey, more than 60 cobalt consumers were canvassed on a monthly or annual basis. Reported consumption and stocks data in tables 1 and 3 contain estimates to account for nonrespondents.

Prices

The annual average U.S. spot price for cathode (minimum of 99.8% cobalt), as reported by Platts Metals Week, was 17% higher than that of 2009 (table 1). Although the price fluctuated during the year, the overall trend was downward. The highest price was \$23.50 to \$24.50 per pound in mid-April, and the lowest price was \$16.00 to \$17.25 per pound in late November.

Trends in Platts' prices for Zambian cobalt (minimum 99.6% cobalt) and Russian cobalt (minimum 99.3% cobalt) were similar to those for U.S. spot cathode. The annual average of weekly prices for Zambian cobalt was \$19.22 per pound, and the annual average of weekly prices for Russian cobalt was \$19.44 per pound.

The London Metal Exchange (LME) launched a cobalt futures contract in February. Cobalt metal was traded in 1-metric-ton

lots (in 100- to 500-kilogram drums) of minimum 99.3% cobalt with impurities specified by the producer for each LME approved brand, to warehouses in Antwerp, Baltimore, Rotterdam, and Singapore. The transactions were by open outcry ring trading, on an electronic trading platform, and by an interoffice telephone market. By yearend, cobalt from the following 11 producers had been approved for delivery: Jiangsu Cobalt Nickel Metal Co. Ltd., Jinchuan Group Ltd., Kasese Cobalt Co. Ltd., Mopani Copper Mines Plc, Nicomet Industries Ltd., OJSC MMC Norilsk Nickel, Sichuan Ni & Co Guorun New Materials Co. Ltd., Sumitomo Metal Mining Co., Ltd., Vale Inco Ltd., Votorantim Metais Niquel SA, and Yantai Cash Industrial Co. Ltd. Even before the cobalt contract was launched, some companies were planning to use LME cobalt prices as reference prices in their sales contracts. In general, trends in LME cobalt prices were similar to trends in spot prices reported by Metal Bulletin, although beginning in mid-September, changes in LME price trends usually preceded those of Metal Bulletin. Yearend LME inventory levels are listed in table 1 (London Metal Exchange Ltd., The, 2010; Metal Bulletin, 2010b; Taarland, 2011, p. 9).

Financial services companies such as Credit Suisse Group and Standard Bank offered financial products based on cobalt, including hedging and speculation products and option and swap contracts (Southgate, 2010).

Foreign Trade

Net import reliance as a percentage of apparent consumption is used to measure the adequacy of current domestic production to meet U.S. demand. Net import reliance was defined as imports minus exports plus adjustments for Government and industry stock changes. Releases from stocks, including shipments from the NDS, were counted as part of import reliance, regardless of whether they were originally imported or produced in the United States. In 2010, net import reliance as a percentage of apparent consumption was 81%. Because there was no measurable U.S. primary cobalt production in 2010, this indicates that 81% of U.S. cobalt supply was from imports and stock releases of primary cobalt and 19% was from domestic or imported scrap.

In 2010, on the basis of contained cobalt, the United States imported 44% more cobalt than it did in 2009 (tables 4, 5). Ten countries supplied 87% of U.S. imports. China was the leading supplier, followed by Russia, Norway, Finland, Australia, Belgium, Zambia, Congo (Kinshasa), Canada, and the United Kingdom.

The United States imported 202 t, gross weight, of unwrought cobalt alloys valued at \$8.9 million. Most of these materials were from Canada (48%) and the United Kingdom (47%). The United States imported 819 t, gross weight, of cobalt waste and scrap valued at \$12.9 million. Seven countries supplied nearly 90% of this material—the United Kingdom (32%), Ireland (28%), Japan (11%), Germany (7%), France and Tunisia (4% each), and Canada (3%). The United States also imported 202 t, gross weight, of wrought cobalt and cobalt articles valued at \$19.1 million. The leading suppliers of these materials were the United Kingdom (30%), Germany (20%), Canada (15%), Belgium and France (12% each), and Japan (6%).

U.S. exports of unwrought cobalt and cobalt contained in chemicals increased by 8% compared with those of 2009. As listed in table 6, the leading destinations for these exports were Ireland, France, the United Kingdom, Canada, Belgium, Germany, and Japan. The United States also exported 1,680 t, gross weight, of wrought metal and cobalt articles valued at \$96.2 million.

World Review

Cobalt was produced as a byproduct of copper, nickel, and other metals, and as a primary product. Primary cobalt production included Moroccan mine and refinery production, the artisanal mining of the mineral heterogenite in Congo (Kinshasa), and the recovery of cobalt from previously stockpiled intermediate materials [for example, slags in Congo (Kinshasa) and Zambia], which were processed primarily to recover cobalt.

Refinery capacity by country is listed in table 7. Plants that processed refined cobalt, used secondary materials (scrap) as their main source of feed, or produced a cobalt product that required further refining were not included.

The European Commission reported the results of a study of 41 economically important minerals and metals. Cobalt was 1 of 14 raw materials identified as critical for European Union supply within 10 years, based on their high economic importance and high risk of supply shortage relative to other materials in the study. For cobalt, the high risk of supply shortage was because a large share of worldwide production comes from Congo (Kinshasa). This was compounded by limited options for substitution (European Commission, 2010, p. 5–6, 23, 36).

The following review by country focuses on operations in production during 2010. Expansions to those operations, operation restarts, and greenfield projects that were forecast to begin producing between 2011 and 2015 are listed in table 8.

Australia.—The Yabulu nickel-cobalt refinery in Townsville, Queensland (owned by Australian businessman Clive Palmer and operated by Queensland Nickel Pty. Ltd.) produced 2,141 t of refined cobalt as cobalt oxide hydroxide; 26% more than the 1,700 t produced in 2009. The increase was attributed to the higher cobalt content of ore processed and Queensland Nickel's efforts to increase the plant's cobalt recovery rate from its traditional level of about 50%. The refinery processed lateritic ore imported from Indonesia, New Caledonia, and the Philippines. Queensland Nickel was interested in obtaining nickel-cobalt intermediate feed for the production line that had been built to process nickel-cobalt mixed hydroxide from the Ravensthorpe operation prior to its closure and sale to First Quantum Minerals Ltd. (Morgan, 2010; Cobalt Development Institute, 2011).

BHP Billiton's Nickel West operations in Western Australia comprised nickel sulfide mines; concentrators, which processed ores mined by BHP Billiton and those from other companies; the Kalgoorlie smelter, where nickel matte was produced; and the Kwinana nickel refinery, which produced cobalt in intermediate nickel-cobalt mixed sulfide.

The Murrin Murrin Nickel Cobalt Joint Venture (60% Minara Resources Ltd. and 40% Glencore) produced 1,976 t of cobalt as metal powder and briquettes from its nickel-cobalt laterite mining and pressure-acid leaching operation near Leonora,

Western Australia, 16% less than the 2,350 t produced in 2009. The decrease was attributed to plant shutdowns for statutory maintenance and to repair an autoclave pipeline failure. Minara's demonstration plant for recovering nickel and cobalt by heap-leaching stockpiled ore-reject material provided 83 t of the cobalt produced. In addition to feed from its own operations, Minara also processed ore from Western Areas NL's Spotted Quoll Mine in 2010 (Minara Resources Ltd., 2011a, p. 16, 18–19; b, p. 24).

OJSC MMC Norilsk Nickel's Western Australian nickel operations remained on care-and-maintenance status throughout the year. In December, Norilsk announced that it planned to restart production from the Lake Johnston nickel sulfide mine and mill during the first half of 2011 (OJSC MMC Norilsk Nickel, 2010, p. 36; 2011, p. 69–70).

Panoramic Resources Ltd. produced concentrates containing 364 t of cobalt (420 t in 2009) from its Savannah underground nickel-copper sulfide mine operation in Western Australia. The concentrates were shipped to Jinchuan's operations in China under a long-term offtake agreement (Panoramic Resources Ltd., 2010, p. 5; 2011, p. 6).

Xstrata Nickel Australasia produced 245 t of cobalt in nickel sulfide concentrates from the Cosmos and Sinclair operations in Western Australia, compared with 459 t in 2009. All the concentrates were sent to Xstrata Nickel's Sudbury smelter in Ontario, Canada (Xstrata plc, 2011b).

Belgium.—According to the Cobalt Development Institute (2011), Umicore's 2010 cobalt refinery production increased to 2,600 t from 2,150 t produced in 2009. The company attributed the increase to greater availability of scrap resulting from higher prices and higher levels of downstream production. Umicore converted cobalt metal, residues, and other cobalt-bearing materials into a wide range of cobalt specialty products, including metal powders, hydroxides, oxides, salts, and compounds. Umicore refined cobalt at plants in Olen, Belgium, and Ganzhou, China. The company processed cobalt at plants in Arab, AL, in the United States; Bruges, Belgium; Fort Saskatchewan, Alberta, Canada; Jiangmen and Shanghai, China; and Cheonan, Republic of Korea. Umicore was expanding the production capability of its plants in Cheonan and Jiangmen to include nickel-manganese-cobalt cathode materials for lithium-ion batteries, began construction on a new battery material plant in Kobe, Japan, and was building an industrial-scale recycling facility for spent rechargeable batteries and battery manufacturing scrap in Hoboken, Belgium (n.v. Umicore, s.a., 2011, p. 5, 26, 70).

Botswana.—Tati Nickel Mining Co. Pty. Ltd. (a Norilsk subsidiary) mined the Phoenix open pit and produced nickel-copper sulfide concentrates, which were toll-smelted by BCL Ltd. in Botswana. BCL also smelted concentrate from its Selebi-Pikwe operation in Botswana and the Nkomati Mine in South Africa. Matte produced by BCL was refined by RioZim Ltd. in Zimbabwe and Xstrata Nickel in Norway (Botswana Gazette, 2009; OJSC MMC Norilsk Nickel, 2010, p. 37).

Brazil.—Votorantim produced cobalt cathode at its refinery in Sao Miguel Paulista, Sao Paulo State, from lateritic nickel-cobalt ore mined from Niquelandia, Goias State and nickel sulfide concentrate from Mirabela Nickel Ltd. The

company also produced nickel matte, primarily from sulfide ores mined and smelted at Fortaleza de Minas, Minas Gerais State.

Mirabela Nickel continued to ramp up production from its Santa Rita open pit nickel sulfide mine and concentrator in Bahia State, and by yearend, produced 179 t of cobalt in concentrate (14 t in 2009). All concentrate produced from Santa Rita was committed via offtake agreements with Votorantim (50%) and Norilsk (50%) (Mirabela Nickel Ltd., 2011).

Canada.—Vale S.A. (formerly Vale Inco Ltd.) produced 1,066 t of cobalt in 2010, 32% less than the 1,575 t produced in 2009. Production during the past 2 years was reduced by labor strikes at its operations in Sudbury from July 2009 to July 2010 and Voisey's Bay from August 2009 through January 2011. Vale reported production in the form of cathode, 438 t, from its Port Colborne, Ontario, refinery; cobalt hydrate, 499 t, from its Thompson, Manitoba, refinery; and cobalt contained in unrefined products such as nickel concentrates, 129 t. Vale's cobalt originated from nickel sulfide ores from company mines at Sudbury, Ontario; Thompson, Manitoba; and Voisey's Bay in northeastern Labrador; and purchased feedstocks. Vale reported the following distribution of sources for its cobalt production: Voisey's Bay, 524 t (971 t in 2009); Ontario, 302 t (359 t in 2009); Manitoba, 189 t (181 t in 2009); and external sources, 51 t (64 t in 2009). Concentrates from Voisey's Bay are being smelted and refined at Sudbury and Thompson until the Long-Harbour refinery is operational (table 8). Vale planned to phase out smelting and refining at Thompson by 2015 (Vale S.A., 2011, p. 35–36, 44–45).

Xstrata Nickel produced 341 t of cobalt in concentrates from mines at Sudbury (277 t in 2009) and 567 t of cobalt in concentrate from its Raglan Mine in Quebec (586 t in 2009). Nickel-copper matte containing 2,634 t of cobalt was produced at the company's Sudbury smelter (2,476 t in 2009); this was refined at Xstrata's Nikkelverk refinery in Norway. Some of the cobalt in the matte originated from ores produced at company mines in Australia and Canada and some originated from custom feed materials, which were primarily nickel concentrates, nickel-copper-cobalt secondary materials (scrap), and copper-cobalt white alloy purchased from Glencore. Custom feed from mining operations included nickel sulfide ores containing approximately 50 t of cobalt from URSA Major Minerals Inc.'s Shakespeare Mine in Ontario, nickel sulfide concentrates produced by Crowflight Minerals Inc.'s Bucko Lake nickel mine in the Thompson Nickel Belt of Manitoba and Liberty Mines Inc. in Ontario, and a copper-nickel-PGM-precious metals concentrate containing approximately 4 t of cobalt from North American Palladium Ltd.'s Lac des Iles Mine in Northern Ontario. Secondary custom feed materials included battery-manufacturing scrap, high-grade slags, metal residues, smelter byproducts, spent batteries and catalysts, superalloy and other alloy scrap, and other secondary materials (Tollinsky, 2008; Xstrata Nickel, 2008, p. 9–11, 21; North American Palladium Ltd., 2011, p. 15; URSA Major Minerals Inc., 2011; Xstrata plc, 2011a, p. 205; 2011b).

The Fort Saskatchewan refinery of the joint venture of Sherritt International Corp. and General Nickel Co. S.A. produced 3,706 t of cobalt as metal powder and briquettes in 2010, slightly less than the 3,721 t produced in 2009. Approximately 96% of the cobalt was from nickel-cobalt mixed sulfides from the joint venture's operations at Moa Bay, Cuba; the remainder

was from purchased feed materials. During 2010, the joint-venture partners reviewed alternative strategies for completing the phase 2 expansion of the refinery, which was suspended in 2008. As a result of a United States embargo on imports of products originating from Cuba, cobalt and nickel produced by Sherritt cannot be sold to customers in the United States (Sherritt International Corp., 2011, p. 7–8, 10).

First Nickel's Lockerby Mine was on care-and-maintenance status all year. In 2010, Liberty Mines produced nickel sulfide ore from its Redstone and McWatters Mines near Timmins, Ontario, which was processed at the company's Redstone Mill. The resulting concentrates, containing 17 t of cobalt in 2010, were shipped to Xstrata Nickel's smelter in Sudbury (Liberty Mines Inc., 2011, p. 1–4).

China.—China's total production of refined cobalt was nearly 34,000 t, which made it the world's leading producer. In 2010, only a small portion of China's cobalt production originated from domestic mines or recycled scrap. Most of the production was from imported ores, concentrates, and semirefined materials, the majority which was sourced from Congo (Kinshasa). CRU International Ltd. (London, United Kingdom) estimated that China imported 35,300 t of cobalt contained in ores, concentrates, and semirefined materials in 2010, up from 24,900 t in 2009. China's imports of cobalt ores and concentrates increased by 11% and imports of semirefined materials more than doubled in 2010 compared with those of 2009 (Collignon, 2011, p. 7–8; CRU International Ltd., 2011, p. 7; Xu, 2011, p. 5, 7).

Numerous companies refined and (or) processed cobalt in China. The leading four refiners were Jinchuan, Zhejiang Huayou Cobalt Nickel Materials Co., Ltd., Zhejiang Galico Cobalt & Nickel Material Co., Ltd., and Ganzhou Yi Hao Umicore Industries, listed in descending order of 2010 estimated cobalt production. Jinchuan produced cobalt as cathode and other products from its refinery at Jinchang, Gansu Province. Some of Jinchuan's cobalt production was from domestic nickel-copper-cobalt sulfide ores mined and refined at Jinchang and some was from other cobalt or nickel feeds. Jinchuan's other feeds included cobalt intermediates (chemical compounds), which were either imported or produced in China from imported concentrates; nickel-copper concentrates from Australia, Spain, and Zambia; nickel concentrates from Australia; and nickel matte from BHP Billiton (Metal Bulletin Daily, 2009; CRU International Ltd., 2011, p. 4, 6).

Congo (Kinshasa).—Congo (Kinshasa) was the world's leading producer of mined cobalt. Some of the country's cobalt mine production was from copper-cobalt ores mined by traditional methods, and some was gathered by tens of thousands of artisanal miners hand-picking cobalt-rich ores. Some of Congo (Kinshasa)'s ores and concentrates were exported, some were processed to semirefined materials such as cobalt carbonate, cobalt hydroxide, or cobalt-bearing alloys, and some were refined to cobalt metal. China was the leading destination for Congo (Kinshasa)'s cobalt exports. As discussed in the "China" section of this report, exports of cobalt materials to China increased in 2010 compared with those of 2009. In an effort to encourage refining of copper and cobalt materials in-country, the Government of Congo (Kinshasa) prohibited

the export of unrefined minerals. The governor of Katanga Province, where copper and cobalt were mined, then signed a law that allowed companies to export concentrates if they paid a tax of \$60 per metric ton (Kavanagh, 2010).

The Government of Congo (Kinshasa) completed its review of mining contracts signed between private companies and the Government or Government-owned companies. The review, which began in 2007, was intended to evaluate whether each contract gave a fair share of its revenues to the country and to determine whether it should be maintained, renegotiated, or terminated. The contract for the Kolwezi Tailings project, which was being developed by First Quantum, was terminated in early 2010. As a result, First Quantum and the project's other contributing partners commenced international arbitration on the matter (First Quantum Minerals Ltd., 2011, p. 32–33).

Korea Resources Corp. and Korea Water Resources Corp. signed an agreement for two ventures with Congolese mining company S.A. Groupe George Forrest and international investment firm Alfonso Rowemberg Korea Ltd. Under the agreement, the South Korean companies were to assist in dam building, water system, and other infrastructure projects including a cobalt processing plant, in exchange for supplies of copper, cobalt, and uranium (Chung-un, 2010).

La Générale des Carrières et des Mines (Gécamines) produced 745 t of refined cobalt, compared with 415 t produced in 2009 (Cobalt Development Institute, 2011).

Kamoto Copper Co. SARL (KCC, a joint venture of Katanga Mining Ltd. and Gécamines) increased its production of cobalt cathode to 3,437 t from 2,534 t in 2009. The company's Luilu refinery processed concentrates produced at the Kamoto concentrator from ore extracted from the Kamoto underground mine, T17 open pit, and the large Kamoto-East Olivera Virgule (KOV) open pit mine, which began commercial production in 2010. During the year, the company continued to make improvements at the mines, concentrator, and refinery, and announced that it planned additional increases in capacity (table 8). Glencore had an offtake agreement for all of KCC's copper and cobalt output; Katanga Mining reported that concentrate was sold to Mopani Copper Mines in Zambia in 2010 (Katanga Mining Ltd., 2011, p. 2–4, 26).

In late 2009, Eurasian Natural Resources Corp. PLC (ENRC) acquired Central African Mining & Exploration Company plc (CAMEC), including CAMEC's 70% share in Boss Mining Sprl; Gécamines held the remaining 30%. In 2010, ENRC increased its African copper-cobalt assets by acquiring Congo Cobalt Corporation Sprl and Société Minière de Kbolela et de Kipese in Congo (Kinshasa), forming a joint venture with Camrose Resources Ltd. in Congo (Kinshasa), and acquiring a majority interest in Chambishi Metals plc in Zambia. Boss Mining mined copper-cobalt ore from open pits in the Mukondo Mountain, Disele, and Kbolela North deposits and produced concentrates containing 8,273 t of cobalt, compared with 6,697 t in 2009. By yearend, Boss Mining had completed construction of a new cobalt solvent extraction–electrowinning (SX–EW) plant at Luita and expected to begin producing cobalt metal in 2011 (Eurasian Natural Resources Corp. PLC, 2011a, p. 19, 40, 46; b, p. 17).

Gécamines and L'Enterprise Générale Malta Forrest S.P.R.L. produced 2,545 t of cobalt in copper-cobalt concentrate from the

Luiswishi Mine and Kipushi concentrator. Production in 2009 was only 437 t of cobalt in concentrate because of a temporary suspension of operations that began in late 2008 in response to low demand and prices (Harrison, 2008; La Générale des Carrières et des Mines, undated).

The Big Hill smelter at Lubumbashi [operated as a joint venture between Gécamines, OM Group, Inc. (OMG), and Groupe George Forrest] processed stockpiled slag to produce alliage blanc, an alloy of cobalt and copper, which was refined at OMG's Kokkola refinery in Finland. In 2010, the smelter produced 4,232 t of cobalt contained in alliage blanc, compared with 4,590 t in 2009 (George Forrest International S.A., 2010; La Générale des Carrières et des Mines, undated).

Freeport-McMoRan Copper & Gold Inc. (FCX) produced 9,302 t of cobalt in hydroxide from its Tenke Fungurume project, compared with approximately 1,360 t (3 million pounds) in 2009. The project, between the towns of Kolwezi and Likasi, comprised open pit mining of sediment-hosted copper-cobalt ore, recovering the metals by agitation leaching, and SX–EW to produce copper cathode and cobalt hydroxide. FCX was planning a second phase of the project, which would optimize production from the current plant and expand its capacity. By yearend, the Government of Congo (Kinshasa) had completed its review of Tenke Fungurume Mining S.A.R.L.'s mining contracts. As part of the review, the contracts were amended to increase Gécamines ownership in Tenke Fungurume to 20%. FCX's ownership was reduced to 56% and Lundin Mining Corp.'s to 24% (Freeport-McMoRan Copper & Gold Inc., 2011, p. 43; La Générale des Carrières et des Mines, undated).

Chemaf SPRL mined copper-cobalt oxide ores from the Etoile open pit mine and processed run-of-mine ore, concentrates, and purchased ore at its SX–EW plant at Usoke in Lubumbashi. The plant produced 2,744 t of cobalt contained in carbonate, slightly less than the 2,780 t produced in 2009 (Shalina Resources Ltd., 2010; undated).

Metorex Ltd.'s Ruashi operation north of Lubumbashi comprised mining copper-cobalt oxide ores from open pits and then milling and processing the ore in the Ruashi phase 2 SX–EW refinery. In 2010, production of cobalt in carbonate increased to 3,580 t from 2,198 t in 2009. Gécamines had a 25% interest in the Ruashi operation (Metorex Ltd., 2011, p. 36–37).

Société Minière du Katanga sprl (Somika) mined and beneficiated copper-cobalt ore and refined the concentrate at its hydrometallurgical copper refinery in Lubumbashi. The refinery had the capacity to produce 2,160 t/yr of cobalt hydroxide (Société Minière du Katanga sprl, undated).

CuCo Resources Ltd. (Toronto, Ontario, Canada) commissioned a cobalt beneficiation plant at its Kisanfu property in the Kolwezi mining district. The commercial plant, which was expected to produce 3,000 t of cobalt in concentrates during the second half of 2011, was an expansion of a small pilot plant built by the company. Concentrates produced at Kisanfu were to be sold to Somika for processing (Metal Bulletin, 2010a; CuCo Resources Ltd., 2011).

Cuba.—Moa Nickel S.A. (part of the 50–50 joint venture between Sherritt and General Nickel) mined nickel-cobalt laterites at Moa Bay, Holguin Province, and produced mixed sulfides, which were sent to the joint venture's Fort Saskatchewan refinery in

Canada. In 2010, the mixed sulfides contained a record 37,745 t of nickel and cobalt, slightly more than the 37,328 t produced in 2009. The increase in production was mainly attributed to stable operating conditions at the recently expanded Moa plant. During the year, the joint-venture partners reviewed alternative strategies for the completion of the phase 2 expansion of the plant, which was suspended in 2008 (Sherritt International Corp., 2011, p. 7–8, 10).

The Ernesto Che Guevara and Rene Ramos Latour Mining and Metallurgical Combines also mined nickel-cobalt laterites and produced mixed nickel-cobalt sulfides in Holguin Province. Nickel and cobalt of Cuban origin cannot be imported into the United States because of a United States embargo on imports from Cuba.

Finland.—OMG's production of refined cobalt, as metal powders, briquettes, oxides, and compounds, was 5% higher than that of 2009. The company's Kokkola Chemicals Oy refinery processed raw materials sourced primarily from Congo (Kinshasa), Finland, and Russia. Most of the feed was alliage blanc from the Big Hill smelter in Congo (Kinshasa), crude cobalt hydroxide from Norilsk's Monchegorsk nickel refinery in Russia, and cobalt sulfate solution from Norilsk's Harjavalta nickel refinery in Finland. OMG also refined materials from other sources, such as ores and concentrates, sulfides, metallic feeds, and secondary materials (scrap) (OM Group, Inc., 2011, p. 6–7, 33; Thomson Reuters, 2011, p. 12).

Talvivaara Mining Co. Plc continued to ramp up and optimize production from its polymetallic sulfide mine and bioheap-leaching operation in Sotkamo in central Finland. As part of its plan to increase the operation's production capacity, the company added a second production line to its metal recovery plant (table 8). During the year, the company sold nickel-cobalt sulfide containing 94 t of cobalt to Norilsk for processing at Harjavalta (Talvivaara Mining Co. Plc, 2011, p. 5–7).

Belvedere Resources Ltd. purchased the Hitura nickel-copper sulfide mine from administrators and restarted production. Nickel-copper concentrates containing an estimated 37 t of cobalt were sold to Jinchuan in 2010 (Belvedere Resources Ltd., 2011, p. 1–2).

France.—The Eramet Group's production of cobalt chloride from its refinery at Sandouville was 18% less than that produced in 2009. Feed for the refinery was nickel matte imported from Eramet subsidiary Le Nickel SLN's Doniambo smelter in New Caledonia (Cobalt Development Institute, 2011).

India.—According to an estimate by the Cobalt Development Institute (2011), India's cobalt production increased by 19% from that of 2009. Nicomet Industries Ltd. and Rubamin Ltd. were India's leading cobalt producers.

Indonesia.—PT International Nickel Indonesia Tbk (PT Inco) produced nickel matte from lateritic ores at its integrated mining and smelting operation near Sorowako on Sulawesi Island. Cobalt contained in matte deliveries increased to 1,196 t from 891 t in 2009. PT Inco sold its entire matte production to Vale (80%) and Sumitomo Metal Mining Co., Ltd. (20%) under long-term contracts (PT International Nickel Indonesia Tbk, 2011, p. 175).

PT Antam Tbk exported lateritic nickel-cobalt ore to Queensland Nickel's Yabulu refinery for processing (CRU International Ltd., 2011, p. 4).

Japan.—Sumitomo's production of electrolytic cobalt at its Niihama nickel refinery increased by 45% from that of 2009, as a result of an increase in nickel-cobalt mixed sulfide feed from the Coral Bay Nickel Corp. plant in the Philippines. The refinery also processed nickel matte from BHP Billiton's Nickel West operations and PT Inco in Indonesia. Sumitomo planned to increase Niihama's production capacity to accommodate the nickel-cobalt mixed sulfide feed that would be generated from its Taganito project in the Philippines (table 8) (Cobalt Development Institute, 2011; CRU International Ltd., 2011, p. 4; Sumitomo Metal Mining Co., Ltd., 2011).

Morocco.—Cie. de Tifnout Tighanimine (CTT) produced cobalt hydroxide at its processing plant at Bouazzer and cobalt cathode and oxide at its Guemassa hydrometallurgical refinery north of Marrakech. CTT's cobalt production was from domestic cobalt-arsenic deposits and heterogenite imported from Congo (Kinshasa).

New Caledonia.—Vale nearly completed the commissioning of its Vale New Caledonia project in the southern tip of New Caledonia's main island. The project, which was originally called Goro, comprised a nickel-cobalt laterite mine, high pressure acid leaching processing plant, and refinery. Initial production was in the form of an intermediate nickel-cobalt hydroxide cake, which was sold to other companies for refining. Vale expected to ramp up production during a 3-year period to reach the nominal production capacity of 60,000 t/yr of nickel contained in nickel oxide and 4,600 t/yr of cobalt contained in cobalt carbonate. Vale's partners in the project were Sumitomo Metal Mining, Mitsui & Co., Ltd., and Société de Participation Minière du Sud Calédonien S.A.S., listed in order of percent share (Vale S.A., 2011, p. 37).

Lateritic nickel-cobalt ore was exported to Queensland Nickel's Yabulu refinery for processing. Nickel matte from Le Nickel SLN's Doniambo smelter was sent to Eramet's refinery in Sandouville, France, where nickel products and cobalt chloride were produced.

Norway.—Xstrata Nickel's production of cobalt cathode at its Nikkelverk refinery was 9% less than that of 2009. The cobalt originated from Xstrata Nickel mines in Australia and Canada, recycled materials, and custom feeds, which included matte from Botswana processed under a long-term agreement with BCL, and copper-cobalt white alloy purchased from Glencore. The white alloy agreement included a metal return component for cobalt. In 2010, Xstrata purchased 15 t of cobalt in white alloy (250 t in 2009) and returned 64 t of cobalt metal (297 t in 2009). Glencore was the sole distributor of Xstrata's cobalt. In 2010, Xstrata sold 3,104 t of cobalt to Glencore (3,066 t in 2009) (CRU International Ltd., 2011, p. 4; Xstrata plc, 2011a, p. 205; b).

Philippines.—Coral Bay Nickel (a joint venture between Sumitomo, Mitsui & Co., Ltd., Sojitz Corp., and Rio Tuba Nickel Mining Corp., listed in order of percent share) produced nickel-cobalt mixed sulfide from its high-pressure acid-leaching

operation at the Rio Tuba nickel laterite mine on Palawan Island. The mixed sulfide was refined by Sumitomo in Japan.

Russia.—Norilsk conducted nickel-copper sulfide mining, ore beneficiation, concentrate smelting, and metal refining on the Kola and Taimyr Peninsulas. Cobalt from ores mined on the Taimyr Peninsula was refined to metal at the company's nickel plant at Norilsk. According to the Cobalt Development Institute (2011), the company produced 2,460 t of refined cobalt, 5% more than the 2,352 t produced in 2009. At Norilsk's nickel plant in Monchegorsk on the Kola Peninsula, high-grade matte produced from both regions was refined. The intermediate cobalt hydroxide produced from the matte was sent to OMG's operations in Finland under a 5-year supply agreement that began in 2007. Under this agreement, Norilsk was to supply OMG with up to 2,500 t/yr cobalt metal, up to 2,500 t/yr of cobalt contained in cobalt hydroxide, and up to 1,500 t/yr of cobalt contained in cobalt sulfate solution. In 2010, Gipropoekt Institute began to develop detailed designs for the production of electrolytic cobalt at Monchegorsk (OJSC MMC Norilsk Nickel, 2011, p. 7–9, 23; OM Group, Inc., 2011, p. 6; Thomson Reuters, 2011, p. 12).

South Africa.—The Nkomati nickel sulfide mine (a joint venture of African Rainbow Minerals Ltd. and Norilsk) produced 667 t of cobalt in 2010, two times the 333 t produced in 2009. The increase resulted from progress on the Nkomati large-scale expansion project. At full steady-state production, forecast for 2013, the mine was expected to produce 1,000 t/yr of cobalt in concentrates (African Rainbow Minerals Ltd., undated; 2011a, p. 19–20; 2011b, p. 63).

Cobalt was also produced as a byproduct from some of South Africa's PGM operations. Two companies produced refined cobalt. Rustenburg Base Metals Refiners (Proprietary) Ltd. (a subsidiary of Anglo American plc) produced cobalt sulfate at its base-metal refinery near Rustenburg, Northwest Province. The company was increasing the nickel capacity of the refinery to 33,000 t/yr from 21,500 t/yr; an equivalent increase in cobalt capacity was expected (table 8). Impala Platinum Ltd. produced cobalt metal powder at its base-metals refinery near Springs, Gauteng Province. Some of the cobalt produced by Impala was recovered from concentrates produced at the Mimosa platinum mine in Zimbabwe. Two other platinum producers—Lonmin plc and Northam Platinum Ltd.—operated base-metal refineries and produced semirefined nickel sulfate containing cobalt.

Spain.—Lundin Mining Corp.'s Aguablanca open pit nickel sulfide mine and processing plant in Badajoz Province produced nickel-copper concentrate containing an estimated 150 t of cobalt, which it sold to Glencore under a long-term sales agreement. Operations at Aguablanca were suspended at yearend following a significant slope failure that affected the main access ramp to the pit (Lundin Mining Corp., 2010).

Uganda.—Kasese Cobalt Co. Ltd. produced cobalt cathode from stockpiled pyrite concentrates using a bacterial leaching-SX-EW process at its cobalt refinery in southwestern Uganda. At current production rates, the stockpile was expected to be exhausted in 2013. The company hoped that production would restart at the nearby Kilembe Mine, so that more feed would become available for its refinery (Metal Bulletin, 2009).

Zambia.—Mopani Copper Mines produced 1,092 t of cobalt metal at its Nkana cobalt refinery, a decrease from the 1,271 t produced in 2009 and 1,458 t produced in 2008. Approximately 73% of the cobalt originated from company sources, mainly the Nkana underground copper-cobalt mine; the remaining 27% originated from third party sources (Glencore International plc, 2011a, p. 12; b, p. 72).

ENRC completed its acquisition of Enya Holdings BV, which held a 90% interest in Chambishi Metals plc. The Chambishi refinery produced 3,265 t of cobalt metal, a significant increase from the 235 t produced in 2009. Feed for the refinery was mined in Congo (Kinshasa), and included carbonate from Luita and hydroxide from Tenke Fungurume (Platts Metals Week, 2010; Cobalt Development Institute, 2011; Eurasian Natural Resources Corp. PLC, 2011a, p. 19, 31, 40).

Konkola Copper Mines Plc (KCM) mined copper ores from its Nchanga and Konkola operations. The company's main source of cobalt was its Nchanga open pit. Cobalt in concentrate was processed to a copper-iron-cobalt alloy at the company's Nchanga copper smelter in Chingola. KCM planned to expand the cobalt production capacity of the smelter (table 8) (Finfacts, 2010; Vedanta Resources plc, 2010, p. 15).

NFC Africa Mining plc [85% China Nonferrous Metal Mining Group Co. Ltd. (CNMC) and 15% ZCCM Investments Holdings Plc.] made investments at its Luanshya Copper Mine operation, which included upgrading the concentrator and installing a new hoisting system at the Baluba copper-cobalt mine (Chulu, 2010; Platts Metals Week, 2011).

Chambishi Copper Smelter Ltd. (a joint venture between CNMC and Yunnan Copper Industry Group Co. Ltd.) smelted concentrates from NFC Africa Mining's Chambishi Mine and other Zambian copper mines. The smelter had the capacity to produce 150,000 t/yr of copper and 2,800 t/yr of cobalt. Equinox Minerals Ltd. had an offtake agreement with Chambishi Copper Smelter to process copper concentrates from its Lumwana Mine. Equinox also sent Lumwana concentrates to KCM's Nchanga smelter for processing (Interfax China Ltd., 2008; Equinox Minerals Ltd., 2011, p. 18).

Metorex produced 42 t of cobalt in cobalt carbonate at its Sable Zinc copper electrowinning plant near Kabwe, compared with 39 t produced in 2009. The low cobalt production levels in recent years were attributed to the low cobalt grades of the Zambian copper concentrates processed by the plant (Metorex Ltd., 2011, p. 40–41).

Albidon Ltd. restarted concentrate production at its Munali nickel mine in southern Zambia. Shipments of nickel-copper-cobalt-PGM sulfide concentrate from Munali to Jinchuan resumed in April (Albidon Ltd., 2010).

Zimbabwe.—Bindura Nickel Corp.'s Shangani and Trojan nickel sulfide mines, smelter, and refinery remained on care-and-maintenance status throughout the year. The company developed plans to resume production from the Trojan mine and concentrator. Nickel concentrates would be sold for further processing until the smelter and refinery were restarted. Cobalt hydroxide was one of the products from the company's refinery (Mwana Africa PLC, 2010, p. 11, 13). Aquarius Platinum Ltd. produced 79 t of cobalt from its Mimosa platinum mine (74 t in

2009). The concentrates were refined by Impala in South Africa (Aquarius Platinum Ltd., 2010, p. 13; 2011, p. 13).

Outlook

Trends in cobalt consumption closely follow those of global industrial production. The global economic downturn that began in late 2008 resulted in reduced demand for cobalt in 2008 and 2009, affecting all major end-use sectors. As global economic conditions improved in 2009 and 2010, cobalt consumption increased. In 2010, there was a firm recovery in superalloy orders, particularly from the aerospace sector, and growth in cobalt consumption for superalloy production was forecast to rise by about 10% per year during 2011–13. In the rechargeable battery market, strong growth during the first half of 2010 was followed by a slowdown during the second half owing to a weakening of consumer confidence and reduced demand for electronic devices. In spite of this, cobalt consumption to make rechargeable batteries was forecast to increase by 14% per year during 2011–13 (Collignon, 2011).

During the first half of 2011, the world production of refined cobalt was estimated to be 13% higher than that of the first half of 2010. In the next few years, global increases in supply from existing producers and new projects are forecast to outpace increases in consumption. In addition, prices during 2010 and early 2011 were still above the estimated marginal cost of cobalt production of approximately \$13.50 per pound. Thus, if an oversupply of cobalt were to take place, it could put downward pressure on near term prices (Collignon, 2011; CRU International Ltd., 2011, p. 6).

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TABLE 1
SALIENT COBALT STATISTICS¹

(Metric tons, cobalt content, unless otherwise specified)

	2006	2007	2008	2009	2010	
United States:						
Consumption:						
Reported	9,280	9,320	8,820 ^r	7,470 ^r	8,030	
Apparent	11,000	9,630	10,100	7,580 ^r	10,300	
Imports for consumption	11,600	10,300	10,700	7,680	11,100	
Exports	2,850	3,100	2,850	2,440	2,640	
Stocks, December 31:						
Industry ²	737	620	582	525 ^r	630	
London Metal Exchange (LME), U.S. warehouse	XX	XX	XX	XX	23	
U.S. Government ³	1,290	676	473	293	301	
Price, metal ⁴	dollars per pound	17.22	30.55	39.01	17.86	20.85
World:						
Production:						
Mine	70,000 ^r	71,700 ^r	76,400 ^r	72,100 ^r	89,500 ^c	
Refinery	53,800	53,300	57,300 ^r	59,700 ^r	76,400	
Stocks, December 31, LME ⁵	XX	XX	XX	XX	278	

^cEstimated. ^rRevised. XX Not applicable.

¹Data are rounded to no more than three significant digits, except prices.

²Stocks held by cobalt processors and consumers.

³Defense Logistics Agency, DLA Strategic Materials (formerly Defense National Stockpile Center). Data for 2006 include material committed for sale pending shipment; data for 2007–10 are uncommitted material only.

⁴Annual average U.S. spot price for minimum 99.8% cobalt cathode reported by Platts Metals Week.

⁵Stocks held in Asia, Europe, and the United States.

TABLE 2
U.S. GOVERNMENT NATIONAL DEFENSE STOCKPILE
SALES AND SHIPMENTS¹

(Metric tons, cobalt content)

	2009	2010
Sales:		
Fiscal year ²	187	6
Calendar year	169	--
Shipments: ³		
Fiscal year ²	192	3
Calendar year	180	-8

-- Zero.

¹Data are rounded to no more than three significant digits.

²Twelve-month period ending September 30 of year stated.

³Calculated from yearend inventory levels. Yearend data are uncommitted material only. Negative numbers are the result of inventory adjustments.

Source: Defense Logistics Agency, DLA Strategic Materials (formerly Defense National Stockpile Center).

TABLE 3
U.S. REPORTED CONSUMPTION AND STOCKS OF COBALT^{1,2}

(Metric tons, cobalt content)

	2009	2010
Consumption by end use:		
Steels	520 ^r	550
Superalloys	3,570 ^r	3,740
Alloys, excludes steels and superalloys:		
Magnetic alloys	287 ^r	357
Other alloys ³	331 ^r	364
Cemented carbides ⁴	503	696
Chemical and ceramic uses	2,190	2,260
Miscellaneous and unspecified	63	63
Total	7,470 ^r	8,030
Consumption by form:		
Chemical compounds, organic and inorganic ⁵	2,130	2,180
Metal	3,550 ^r	3,860
Purchased scrap	1,790	2,000
Total	7,470 ^r	8,030
Stocks, December 31: ⁶		
Chemical compounds, organic and inorganic ⁵	171	173
Metal	W	W
Purchased scrap	W	W
Total	525 ^r	630

^rRevised. W Withheld to avoid disclosing company proprietary data; included in "Total."

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes estimates.

³Includes nonferrous alloys, welding materials, and wear-resistant alloys.

⁴Includes diamond tool matrices, cemented and sintered carbides, and cast carbide dies or parts.

⁵Includes oxides.

⁶Stocks held by cobalt processors and consumers.

TABLE 4
U.S. IMPORTS FOR CONSUMPTION OF COBALT, BY FORM¹

	2009			2010		
	Gross weight (metric tons)	Cobalt content ² (metric tons)	Value (thousands)	Gross weight (metric tons)	Cobalt content ² (metric tons)	Value (thousands)
Metal ³	5,870	5,870	\$198,000	8,750	8,750	\$350,000
Oxides and hydroxides	1,460	1,050	37,500	2,010	1,450	60,700
Other forms:						
Acetates	168	40	1,220	301	72	2,720
Carbonates	972	447	18,000	686	315	14,400
Chlorides	231	58	2,220	311	78	2,580
Sulfates	760	205	5,900	1,440	388	9,200
Total	9,470	7,680	262,000	13,500	11,100	439,000

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Estimated from gross weights.

³Unwrought cobalt, excluding alloys and waste and scrap.

Source: U.S. Census Bureau.

TABLE 5
U.S. IMPORTS FOR CONSUMPTION OF COBALT, BY COUNTRY¹

Country of origin	Metal ²			Oxides and hydroxides					Other forms ³			Total			
	Gross weight (metric tons)	Cobalt content ⁴ (metric tons)	Value ⁵ (thousands)	Gross weight (metric tons)	Cobalt content ⁴ (metric tons)	Value ⁵ (thousands)	Gross weight (metric tons)	Cobalt content ⁴ (metric tons)	Value ⁵ (thousands)	Gross weight (metric tons)	Cobalt content ⁴ (metric tons)	Value ⁵ (thousands)	Gross weight (metric tons)	Cobalt content ⁴ (metric tons)	Value ⁵ (thousands)
2009:															
Australia	380	380	\$11,600	--	--	--	--	--	--	--	--	--	380	380	\$11,600
Belgium	99	99	4,560	531	382	\$16,100	69	24	\$850	699	505	21,500			
Brazil	172	172	5,280	--	--	--	7	2	60	179	173	5,340			
Canada	246	246	7,820	471	339	8,140	2	(6)	5	719	586	16,000			
China	1,360	1,360	47,800	128	92	3,590	433	150	5,570	1,920	1,600	57,000			
Congo (Kinshasa)	101	101	3,170	--	--	--	--	--	--	101	101	3,170			
Finland	175	175	7,340	151	108	4,020	1,180	438	16,200	1,510	721	27,600			
France	18	18	968	--	--	--	1	(6)	23	19	18	992			
Germany	14	14	1,010	4	3	336	--	--	--	18	16	1,340			
Hong Kong	--	--	--	14	10	335	--	--	--	14	10	335			
India	2	2	47	--	--	--	206	56	1,620	208	58	1,670			
Japan	273	273	10,700	3	2	176	45	12	374	321	287	11,300			
Morocco	247	247	7,550	--	--	--	--	--	--	247	247	7,550			
Norway	1,650	1,650	52,300	--	--	--	--	--	--	1,650	1,650	52,300			
Russia	851	851	28,500	--	--	--	--	--	--	851	851	28,500			
South Africa	26	26	847	1	1	29	--	--	--	27	26	876			
Taiwan	5	5	99	--	--	--	40	9	91	44	14	190			
Uganda	30	30	968	--	--	--	--	--	--	30	30	968			
United Kingdom	42	42	1,500	149	108	4,580	140	54	2,360	331	204	8,440			
Zambia	183	183	5,080	--	--	--	--	--	--	183	183	5,080			
Other	7	7	331	9	6	226	8	4	173	24	17	730			
Total	5,870	5,870	198,000	1,460	1,050	37,500	2,130	751	27,300	9,470	7,680	262,000			
2010:															
Australia	711	711	28,000	--	--	--	--	--	--	711	711	28,000			
Belgium	198	198	7,310	543	391	19,400	43	11	364	784	601	27,100			
Brazil	166	166	6,930	--	--	--	20	6	245	186	172	7,180			
Canada	141	141	6,700	415	299	9,160	--	--	--	556	440	15,900			
China	2,330	2,330	93,400	355	255	9,850	728	209	3,640	3,410	2,790	107,000			
Congo (Kinshasa)	465	465	14,300	--	--	--	--	--	--	465	465	14,300			
Finland	276	276	14,600	242	174	7,820	1,150	403	16,500	1,660	854	38,900			
France	23	23	1,490	--	--	--	74	18	393	97	42	1,880			
Germany	15	15	857	7	5	649	(6)	(6)	3	22	20	1,510			
India	61	61	2,560	--	--	--	382	103	3,350	443	164	5,910			
Japan	272	272	13,000	4	3	147	--	--	--	276	274	13,200			
Morocco	235	235	9,160	--	--	--	--	--	--	235	235	9,160			

See footnotes at end of table.

TABLE 5—Continued
U.S. IMPORTS FOR CONSUMPTION OF COBALT, BY COUNTRY¹

Country of origin	Metal ²		Oxides and hydroxides				Other forms ³		Total	
	Gross weight (metric tons)	Cobalt content ⁴ (metric tons)	Value ⁵ (thousands)	Gross weight (metric tons)	Cobalt content ⁴ (metric tons)	Value ⁵ (thousands)	Gross weight (metric tons)	Cobalt content ⁴ (metric tons)	Gross weight (metric tons)	Cobalt content ⁴ (metric tons)
Norway	1,240	1,240	\$51,500	--	--	--	--	--	1,240	1,240
Russia	1,520	1,520	56,100	--	--	--	--	--	1,520	1,520
South Africa	321	321	13,400	2	1	\$55	--	--	323	322
Sweden	18	18	748	--	--	--	--	--	18	18
Taiwan	3	3	85	--	--	--	58	16	61	19
Uganda	148	148	6,210	--	--	--	--	--	148	148
United Kingdom	17	17	826	446	321	13,600	260	79	724	418
Zambia	576	576	22,100	--	--	--	--	--	576	576
Other	10	10	360	--	--	--	27	8	38	19
Total	8,750	8,750	350,000	2,010	1,450	60,700	2,740	854	13,500	11,100
									28,900	439,000

-- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Unwrought cobalt, excluding alloys and waste and scrap; includes cobalt cathode and cobalt metal powder; may include intermediate products of cobalt metallurgy.

³Includes cobalt acetates, cobalt carbonates, cobalt chlorides, and cobalt sulfates.

⁴Estimated from gross weights.

⁵Customs value.

⁶Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 6
U.S. EXPORTS OF COBALT IN 2010, BY COUNTRY^{1,2}

Country of destination	Metal ³		Oxides and hydroxides		Acetates		Chlorides		Total	
	Gross weight (metric tons)	Value ⁴ (thousands)	Gross weight (metric tons)	Value ⁴ (thousands)	Gross weight (metric tons)	Value ⁴ (thousands)	Gross weight (metric tons)	Value ⁴ (thousands)	Cobalt content ⁵ (metric tons)	Value ⁴ (thousands)
Argentina	31	\$1,140	--	--	--	--	--	--	31	\$1,140
Australia	4	119	1	\$20	--	--	--	--	5	138
Austria	14	524	--	--	--	--	--	--	14	524
Belgium	96	1,520	96	497	97	\$2,010	--	--	189	4,030
Canada	152	4,120	3	119	188	2,060	2	\$23	200	6,320
China	30	963	--	--	8	372	--	--	31	1,330
France	553	17,600	(6)	13	--	--	--	--	553	17,600
Germany	181	9,360	--	--	--	--	(6)	7	181	9,370
Hong Kong	23	397	(6)	6	--	--	--	--	23	403
India	7	281	118	369	20	212	--	--	96	861
Ireland	672	18,700	--	--	--	--	--	--	672	18,700
Italy	12	543	--	--	--	--	--	--	12	543
Japan	171	8,320	--	--	(6)	23	--	--	171	8,350
Korea, Republic of	25	1,540	--	--	--	--	--	--	25	1,540
Malaysia	19	419	--	--	--	--	27	615	26	1,030
Mexico	1	119	38	1,270	92	1,160	(6)	4	50	2,550
Netherlands	46	1,440	(6)	9	--	--	--	--	46	1,450
Singapore	8	577	--	--	--	--	--	--	8	577
Switzerland	10	457	--	--	--	--	--	--	10	457
Taiwan	53	1,660	--	--	2	21	--	--	53	1,680
Tunisia	11	338	--	--	--	--	--	--	11	338
United Arab Emirates	3	300	--	--	--	--	--	--	3	300
United Kingdom	206	3,350	(6)	9	--	--	--	--	206	3,350
Venezuela	2	79	1	40	--	--	--	--	3	119
Other	18	1,180	1	25	--	--	--	--	18	1,200
Total	2,350	75,000	258	2,380	406	5,860	30	650	2,640	83,900

-- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²In addition to the materials listed, the United States exports cobalt ores and concentrates and wrought cobalt and cobalt articles.

³Includes unwrought cobalt, powders, waste and scrap, and mattes and other intermediate products of cobalt metallurgy.

⁴Free alongside ship value.

⁵Estimated from gross weights.

⁶Less than 1/2 unit.

Source: U.S. Census Bureau.

TABLE 7
WORLD ANNUAL COBALT REFINERY
CAPACITY, DECEMBER 31, 2010^{1,2}

(Metric tons, cobalt content)

Country	Capacity
Australia	6,700
Belgium	1,500
Brazil	1,420
Canada ^e	6,200
China ^e	50,000
Congo (Kinshasa) ^e	10,000
Finland	10,000
France	500
India ^e	2,060
Japan	2,000
Morocco	2,000
Norway	5,200
Russia ^e	6,000
South Africa ^e	850
Uganda	720
Zambia	8,800
Total	114,000

^eEstimated.

¹Data are rounded to no more than three significant digits; may not add to total shown.

²Includes standby capacity. Refinery products include cobalt metal, metal powders, oxides, and (or) salts.

TABLE 8
COBALT: SELECTED PROJECTS SCHEDULED FOR COMPLETION, BY YEAR, BY 2015^{1,2}

Projected year of first production	Country	Project and company ³	Project type ⁴	Principal metal	Ore/feed type	Annual production capacity (metric tons, cobalt content)	Cobalt product
2011 ⁵	Australia	Niwest GME Resources Ltd.	new mine and heap-leaching operation	nickel	nickel-cobalt laterite ore	1,400	Nickel-cobalt sulfide.
2011	Do.	Ravensthorpe First Quantum Minerals Ltd.	reopen mine and modify existing PAL processing operation	do.	do.	1,400	Nickel-cobalt hydroxide.
2011	Canada	Lockerby Depth First Nickel Inc.	expansion of existing mine	do.	nickel-copper-cobalt sulfide ore	80 ⁶	Nickel-copper-cobalt sulfide ore.
2011	Do.	Raglan Mine Xstrata Nickel	expansion of existing mine, stage 1	do.	nickel-copper-cobalt-platinum-group metals sulfide ore	NA ⁶	Nickel concentrate.
2011	China	Cobalt plant, phase I Jiangwu Cobalt Co., Ltd. (Jiangxi Rare Earth & Rare Metals Tungsten Group Holding Co., Ltd., Ganzhou State-Owned Assets Management Co., Ltd., and Ganzhou Expressway Co., Ltd.)	new refinery	cobalt	NA	2,000	NA.
2011	Do.	Jiangsu Runjie New Material Nanjing Hanrui Cobalt Co., Ltd.	do.	do.	cobalt concentrate or cobalt carbonate	2,000	Cobalt metal powder, cobalt oxalate, cobalt carbonate, cobalt oxide.
2011	Congo (Kinshasa)	Kipoi, stage 1 Congo Minerals sprl (subsidiary of Tiger Resources Ltd.) and La Générale des Carrières et des Mines (Gécamines)	new mine and beneficiation plant	copper	copper-cobalt oxide ore	NA	Stockpiled cobalt ore or cobalt concentrate for sale.
2011	Do.	Luilu Metallurgical Plant, accelerated development plan, new phase 3 Katanga Mining Ltd. and La Générale des Carrières et des Mines (Gécamines)	refurbishment and expansion of existing beneficiation plant and refinery	do.	copper-cobalt oxide and sulfide concentrates	8,000 ⁶	Cobalt cathode.
2011	Do.	Luisha South DMS plant—stockpile African Metals Corp.	new beneficiation plant	do.	stockpiled copper-cobalt oxide ore	215	Copper-cobalt concentrate.
2011	Do.	Luita SX-EW line Boss Mining Sprl [Eurasian Natural Resources Corp. PLC and La Générale des Carrières et des Mines (Gécamines)]	addition to existing plant	cobalt	cobalt in solution	3,200 ⁷	Cobalt cathode.

See footnotes at end of table.

TABLE 8—Continued
 COBALT: SELECTED PROJECTS SCHEDULED FOR COMPLETION, BY YEAR, BY 2015^{1,2}

Projected year of first production	Country	Project and company ³	Project type ⁴	Principal metal	Ore/feed type	Annual production capacity (metric tons, cobalt content)	Cobalt product
2011	Congo (Kinshasa)	Mutanda, phase I Mutanda Mining SPRL [Glencore International AG, Groupe Bazano, and La Générale des Carrières et des Mines (Gécamines)]	new refinery	copper	copper-cobalt oxide ore	11,000	Cobalt hydroxide.
2011	Do.	Mutanda, phase 2 Mutanda Mining SPRL [Glencore International AG, Groupe Bazano, and La Générale des Carrières et des Mines (Gécamines)]	expansion of existing operation	do.	do.	23,000 ⁶	Do.
2011	Do.	NA Metal Mines SPRL (Nanjing Hanrui Cobalt Co., Ltd.)	new mines, beneficiation plant, and processing plant	do.	copper-cobalt ore	1,500	Cobalt carbonate.
2011	Papua New Guinea	Ramu Metallurgical Corporation of China Ltd., Jinchuan Group Ltd., Jilin Jien Nickel Industry Co., Ltd., Jiuquan Iron & Steel Group Co., Ltd., Highlands Pacific Ltd., and Mineral Resources Development Co.	new mine, beneficiation plant, and HPAL processing plant	nickel	nickel-cobalt laterite ore	3,300	Nickel-cobalt hydroxide.
2011	South Africa	Base Metals Refinery Anglo Platinum Ltd.	expansion of existing refinery	do.	nickel-cobalt-platinum-group metals converter matte	825 ^{e,6}	Cobalt sulfate.
2011	Zambia	New Nchanga smelter Konkola Copper Mines Plc	expansion of production from existing smelter	copper	copper-cobalt concentrates	5,000 ⁶	Alliage rouge.
2012	Australia	Cawse OJSC MMC Norilsk Nickel	reconfigure existing plant	nickel	nickel sulfide ore	NA	Nickel hydroxide.
2012 ⁵	Do.	Gladstone Nickel, stage 1 Gladstone Pacific Nickel Ltd.	new mine, beneficiation plant, HPAL processing plant, and refinery	do.	nickel-cobalt laterite ore	6,000	Cobalt metal.
2012	Do.	Mount Gunson MG 14 deposit Gunson Resources Ltd.	new mine and beneficiation plant	copper	copper-cobalt-silver sulfide ore	215	Copper-cobalt concentrate.
2012	Do.	Radio Hill Fox Resources Ltd.	new bacterial heap-leaching operation	nickel	nickel-copper sulfide ore and tailings	NA	Nickel-cobalt carbonate.
2012	Do.	Rocklands Group Copper CuDeco Ltd.	new mine and beneficiation plant	copper	copper-cobalt-gold oxide and sulfide ore	NA	Cobaltic-pyrite concentrate.
2012	Brazil	Sao Miguel Paulista refinery Votorantim Metais Niquel SA	expansion of existing refinery	nickel	nickel-cobalt matte	3,100 ⁶	Cobalt cathode.
2012	Canada	Nunavik Nickel Jien Canada Mining Ltd. and Goldbrook Ventures Inc.	new mine and beneficiation plant	do.	nickel-copper-cobalt-platinum-group metals sulfide ore	425 ⁸	Nickel concentrate.

See footnotes at end of table.

TABLE 8—Continued
 COBALT: SELECTED PROJECTS SCHEDULED FOR COMPLETION, BY YEAR, BY 2015^{1,2}

Projected year of first production	Country	Project and company ³	Project type ⁴	Principal metal	Ore/feed type	Annual production capacity (metric tons, cobalt content)	Cobalt product
2012	Congo (Kinshasa)	Luisha South DMS plant— hard rock African Metals Corp.	new mine and beneficiation plant	copper	copper-cobalt oxide and sulfide ores	NA	Copper-cobalt concentrate.
2012	Do.	Usoke refinery, EW plant for cobalt Chemaf SPRL	addition to existing refinery	do.	copper-cobalt ore	3,000 ⁷	Cobalt cathode.
2012	Finland	Kevitsa First Quantum Minerals Ltd.	new mine and beneficiation plant	nickel	nickel-copper- cobalt-platinum- group metals- gold sulfide ore	400 ^{e,8}	Nickel-cobalt- platinum-group metals concentrate.
2012	Do.	Outokumpu stage 1 (formerly Kyllylahti) Altona Mining Ltd. (Universal Resources Ltd. and Vulcan Resources Ltd.)	new mine and refurbished beneficiation plant	copper	copper-zinc-cobalt- nickel-gold sulfide ore	940 ⁸	Cobalt-nickel concentrate. ⁹
2012	Do.	Talvivaara Talvivaara Mining Co. Ltd.	expansion of existing operation	nickel	nickel-zinc-copper- cobalt sulfide ore	1,800 ⁶	Nickel-cobalt sulfide.
2012	Madagascar	Ambatovy Joint Venture Sherritt International Corp., Sumitomo Corp., Korea Resources Corp., SNC- Lavalin Group Inc.	new mine, HPAL processing plant, and refinery	do.	nickel-cobalt laterite ore	5,600	Cobalt metal powder and briquettes.
2012	South Africa	Middleburg smelter Jubilee Platinum plc	adapt existing smelter to include ConRoast process	platinum- group metals- nickel	platinum-group metals concentrates and sludge	NA	Nickel-copper- cobalt-iron- platinum-group metals alloy.
2012 ^{5,10}	Turkey	Caldag European Nickel PLC	mine and heap-leaching operation	nickel	nickel-cobalt laterite ore	1,000	Nickel-cobalt hydroxide.
2012	United States (Idaho)	Idaho Cobalt Formation Metals Inc.	new mine and refinery	cobalt	stratiform cobalt- copper-gold ore	1,625	Cobalt cathode.
2012	Zambia	Chambishi Copper Smelter China Nonferrous Metal Mining Group Co., Ltd. and Yunnan Copper Industry Group Co., Ltd.	expand existing smelter	copper	copper-cobalt concentrates	NA ¹¹	NA.
2012	Do.	Chambishi Metals Eurasian Natural Resources Corp. PLC	new SX-EW cobalt plant	do.	NA	3,000	Cobalt cathode.
2013	Australia	Barnes Hill Proto Resources & Investments Ltd. and Metals Finance Ltd.	new mine and ATML processing plant	nickel	nickel-cobalt laterite ore	400 ^e	Nickel-cobalt intermediate.
2013 ⁵	Do.	Wingellina Nickel Metals X Ltd.	new mine and HPAL processing plant	do.	do.	3,000 ⁸	Nickel-cobalt hydroxide.
2013	Canada	NICO Fortune Minerals Ltd.	new mine, relocated and refurbished beneficiation plant, and refinery	gold	gold-cobalt-bismuth- copper ore	1,550 ⁸	Cobalt cathode.

See footnotes at end of table.

TABLE 8—Continued
 COBALT: SELECTED PROJECTS SCHEDULED FOR COMPLETION, BY YEAR, BY 2015^{1,2}

Projected year of first production	Country	Project and company ³	Project type ⁴	Principal metal	Ore/feed type	Annual production capacity (metric tons, cobalt content)	Cobalt product
2013	Canada	Voisey's Bay Long-Harbour commercial nickel processing plant Vale S.A.	new refinery	nickel	nickel-copper-cobalt sulfide concentrate	2,500	Cobalt cathode.
2013	Congo (Kinshasa)	NA Boss Mining Sprl [(Eurasian Natural Resources Corp. PLC and La Générale des Carrières et des Mines (Gécamines))]	expansion of existing operations	copper	copper-cobalt oxide ore	12,000 ⁶	NA.
2013	Do.	Usoke refinery Chemaf SPRL	expansion of existing refinery	do.	copper-cobalt ore	6,000 ⁶	Cobalt cathode and cobalt hydroxide.
2013	Do.	WOL-SX-EW refinery, new phase 4 Katanga Mining Ltd. and La Générale des Carrières et des Mines (Gécamines)	new beneficiation plant and SX-EW refinery	do.	copper-cobalt oxide and sulfide ore	12,000	Cobalt hydroxide.
2013	Japan	Nihama expansion Sumitomo Metal Mining Co., Ltd.	expansion of existing refinery	nickel	nickel-cobalt sulfide and nickel matte	4,500 ⁶	Cobalt cathode.
2013	Mexico	El Boleo Baja Mining Corp., Korea Resources Corp., L.S. Nikko Copper Inc., Hyundai Hysco Co. Ltd., SK Networks Co. Ltd., and Iljin Copper Foil Co. Ltd.	new mine and refinery	copper	copper-cobalt-zinc-manganese oxide and sulfide ores	2,400	Do.
2013–14	Philippines	Mindoro Nickel Intex Resources ASA	new mine, beneficiation plant, ATML and HPAL processing plant, and refinery	nickel	nickel-cobalt laterite ore	3,300	Cobalt sulfate.
2013	Do.	Taganito Sumitomo Metal Mining Co., Ltd., Nickel Asia Corp., and Mitsui & Co., Ltd.	new HPAL processing plant	do.	do.	2,600	Nickel-cobalt sulfide.
2013	United States (Michigan)	Eagle Kennecott Eagle Minerals Co.	new mine, crusher, and rehabilitated beneficiation plant	nickel-copper	nickel-copper sulfide ore	400 ^e	Copper-nickel concentrate.
2013 ^e	United States (Minnesota)	NorthMet PolyMet Mining Corp.	new mine, beneficiation plant, and refinery	copper	copper-nickel-platinum-group metals sulfide ore	360	Separate nickel and copper concentrates initially, followed by nickel-cobalt hydroxide.
2013	Zambia	Muliashi China Nonferrous Metal Mining Group Co., Ltd.	new mine, heap-leaching operation, and refinery	do.	copper-cobalt oxide ore	1,500	Cobalt hydroxide.

See footnotes at end of table.

TABLE 8—Continued
COBALT: SELECTED PROJECTS SCHEDULED FOR COMPLETION, BY YEAR, BY 2015^{1,2}

Projected year of first production	Country	Project and company ³	Project type ⁴	Principal metal	Ore/feed type	Annual production capacity (metric tons, cobalt content)	Cobalt product
2014	Cameroon	Nkamouna Geovic Mining Corp. and Société National d'Investissement du Cameroun	new mine and processing plant	cobalt	nickel-cobalt laterite ore	6,100 ⁸	Cobalt-nickel sulfide.
2014 ^e	Canada	Makwa Mustang Minerals Corp.	new mine and relocated beneficiation plant	nickel	nickel-copper-platinum-group metals sulfide ore	150 ^e	Nickel concentrate.
2014	Do.	Minago Victory Nickel Inc.	new mine and beneficiation plant	do.	nickel-copper-cobalt-platinum-group metals-precious metals sulfide ore	230 ^{e,8}	Do.
2014	Congo (Kinshasa)	Kipoi, stage 2 Congo Minerals sprl (subsidiary of Tiger Resources Ltd.) and La Générale des Carrières et des Mines (Gécamines)	addition of heap-leaching and SX-EW to existing operation	copper	copper-cobalt oxide ore	800	NA.
2014 ^e	Do.	NA La Sino-Congolaise des Mines Sarl (Sicomines) joint venture ¹²	new mine, beneficiation plant, and smelter	do.	copper-cobalt ore	19,000	Alliage blanc.
2014	Do.	Tenke Fungurume, phase 2 Freeport-McMoRan Copper & Gold Inc., Lundin Mining Corp., and La Générale des Carrières et des Mines (Gécamines)	expansion of existing operation	do.	copper-cobalt oxide, mixed oxide/sulfide, and sulfide ores	16,000 ⁶	Cobalt hydroxide.
2014	Philippines	Acoje European Nickel PLC and DMCI Mining Corp.	new mine and heap-leaching operation	nickel	nickel-cobalt laterite ore	930 ⁸	Nickel-cobalt hydroxide.
2014	Tanzania	Kabanga Barrick Gold Corp. and Xstrata Nickel	new mine and beneficiation plant	do.	nickel sulfide ore	NA	Nickel concentrate.
2014	Zambia	Ichimpe Zhonghui Mining Group Ltd.	new mine	copper	copper-cobalt ore	2,000	NA.
2015	Congo (Kinshasa)	WOL-SX-EW refinery, new phase 5 Katanga Mining Ltd. and La Générale des Carrières et des Mines (Gécamines)	expand new beneficiation plant and SX-EW refinery	do.	copper-cobalt oxide and sulfide ore	22,000 ⁶	Cobalt hydroxide.

^eEstimated. Do., do. Ditto. NA Not available.

¹Estimated data are rounded to no more than three significant digits.

²Projects in feasibility or later stages of development in 2010. Actual startup dates may be postponed owing to economic or other factors. Additional projects might produce cobalt by 2015, but not enough information was available to include them.

³DMS dense media separation. EW electrowinning. SX-EW solvent extraction—electrowinning. WOL-SX-EW whole ore leach—solvent extraction—electrowinning.

⁴ATML Atmospheric leach. HPAL High pressure acid leach. PAL pressure acid leach. SX-EW solvent extraction—electrowinning.

⁵Startup date provided before project postponement was announced; no information is available on the length of delay.

TABLE 8—Continued
COBALT: SELECTED PROJECTS SCHEDULED FOR COMPLETION, BY YEAR, BY 2015^{1,2}

⁶Total capacity following expansion.

⁷Addition will not increase total plant capacity.

⁸Average production.

⁹Cobalt-nickel concentrate will be stockpiled until a marketable product is developed.

¹⁰Placed on care-and-maintenance status until forestry permit is granted.

¹¹Company plans to double copper capacity.

¹²The Sicominex joint venture comprises the following Chinese and Congolese companies: China Railway Group Ltd., Sinohydro Corp., Zhejiang Huayou Cobalt Co., Ltd., and La Générale des Carrières et des Mines (Gécamines).

TABLE 9
COBALT: WORLD MINE PRODUCTION, BY COUNTRY^{1,2}

(Metric tons, cobalt content)

Country ³	2006	2007	2008	2009	2010 ^e
Australia ^{e,4}	5,130	4,730	4,780	4,340 ^r	3,850 ⁵
Botswana ⁶	303	242	337	270 ^r	325
Brazil ^e	1,100	1,311 ⁵	1,215 ⁵	1,200	1,600
Canada ⁷	7,115	8,692	8,953	3,919 ^r	4,568 ^{p,5}
China ^e	1,840	6,100	6,630	6,000	6,500
Congo (Kinshasa) ^{e,8}	27,100	25,400	32,300	35,500	47,400
Cuba ⁹	5,602	4,540	3,175	3,500 ^e	3,600
Finland ^e	100	115	105 ⁵	27	140
Indonesia ¹⁰	1,600	1,600	1,300	1,200	1,600
Madagascar ^e	--	--	--	--	700
Morocco ^{e,11}	2,600 ^r	1,800 ^r	1,700	2,200 ^r	2,200
New Caledonia ¹²	1,629	1,620	869	719 ^r	1,000
Philippines ^e	900	1,000	1,200	1,500	2,200
Russia ^{e,11}	6,300	6,300	6,200	6,100	6,200
South Africa ^e	600	600	590	610	1,800
Zambia ^{e,13}	8,000	7,500	7,000 ^r	4,900 ^r	5,700
Zimbabwe ^{e,14}	110	100	85	74 ⁵	79 ⁵
Total	70,000 ^r	71,700 ^r	76,400 ^r	72,100 ^r	89,500

^eEstimated. ^pPreliminary. ^rRevised. -- Zero.

¹World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Table includes data available through June 9, 2011. Figures represent recoverable cobalt content of ores, concentrates, or intermediate products from cobalt, copper, nickel, platinum, or zinc operations.

³In addition to the countries listed, Spain and Turkey are known to produce ores that contain cobalt, but information is inadequate to make reliable estimates of production. Poland produces copper ore containing 1,500 to 5,000 metric tons per year of cobalt, which is not currently recovered. Other copper-, nickel-, platinum-, or zinc-producing nations may also produce ores containing cobalt as a byproduct component, but recovery is small or nil.

⁴Cobalt content of lateritic nickel ore, nickel concentrate, and zinc concentrate originating from Australia. Quantities of cobalt contained in intermediate or refined metallurgical products produced from Australian and imported ores, in metric tons, were estimated to be as follows: 2006–07—5,500; 2008—5,100; 2009—5,500; and 2010—5,700.

⁵Reported figure.

⁶Reported cobalt content of pelletized nickel-copper matte.

⁷Assay content of cobalt in concentrates produced.

⁸Cobalt content of concentrates, tailings, and slags.

⁹Determined from reported nickel-cobalt content of sulfide and ammoniacal liquor production.

¹⁰Cobalt content of nickel matte plus estimated cobalt in lateritic ore processed in Australia.

¹¹Cobalt content of concentrates.

¹²Cobalt content of limonitic nickel laterite ores mined. Quantities of cobalt contained in intermediate or refined metallurgical products (cobalt chloride and cobalt oxide hydroxide) produced from New Caledonian ores exported to Australia and France, in metric tons, were estimated to be as follows: 2006—1,200; 2007—1,400; 2008—1,200; 2009—1,500; and 2010—1,700.

¹³Cobalt content of concentrates and slags.

¹⁴Estimated cobalt content of intermediate products produced in Zimbabwe from nickel and platinum ores mined in Zimbabwe.

TABLE 10
COBALT: WORLD REFINERY PRODUCTION, BY COUNTRY^{1,2}

(Metric tons, cobalt content)

Country	2006	2007	2008	2009	2010
Australia, metal powder and oxide hydroxide ^e	3,700	3,680	3,620	4,050	4,120
Belgium, metal powder, oxide, hydroxide ³	2,840	2,825	3,020	2,150	2,600
Brazil, metal	902	1,148	994	1,012	1,369
Canada, metal, metal powder, oxide	5,198	5,620	5,637	4,918	4,650 ^p
China, metal, metal powder, oxide, salts ^{e,4}	12,700	13,200	18,200	23,100	32,900
Congo (Kinshasa), metal ⁵	550	606	1,049	2,950	4,182
Finland, metal powder and salts ⁶	8,582	9,173	9,645	8,962	9,413
France, chloride	256	305	311	368	302
India, metal and salts	1,184	980	858	1,001	1,187
Japan, metal	920	1,084	1,071	1,332	1,935
Morocco, metal and oxide	1,405	1,591	1,711	1,600	1,545
Norway, metal	4,927	3,939	3,719	3,510	3,208
Russia, unspecified ^{e,7}	5,000	3,800	2,500	2,350	2,460
South Africa, metal powder and sulfate	267	307	244	238	833
Uganda, metal	674	698	663	673	624
Zambia, metal	4,665	4,335	4,049 ^r	1,506 ^r	5,026
Total	53,800	53,300	57,300 ^r	59,700 ^r	76,400

^eEstimated. ^pPreliminary. ^rRevised.

¹World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Table includes data available through June 24, 2011. Figures represent cobalt refined from ores, concentrates, or intermediate products and do not include production of downstream products from refined cobalt.

³Production reported by n.v. Umicore s.a.; includes production from China that is not otherwise included in this table.

⁴Production from domestic and imported ores and concentrates; excludes production by n.v. Umicore s.a. that is included under Belgium.

⁵Excludes production of cobalt in alloys, carbonate, hydroxide and other materials that would require further refining.

⁶Production for 2006–08 reported by the Geological Survey of Finland; production for 2009–10 reported by OM Group Inc.

⁷Production reportedly includes metal, oxide, and salts; other forms may also have been produced.